INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN PROGRESSIVE EDUCATION & DEVELOPMENT

OPEN ACCESS JOURNAL

Vol 12, Issue 4, (2023) E-ISSN: 2226-6348

Enhancing Higher-Order Thinking Skills among Pre-Service Teachers in China: A Framework of Constructivist Smart Learning Environments Integrating Cognitive and Motivational Factors

Nie Ni[1,2], Samsilah Binti Roslan[1,] Aini Marina Maarof[1], Tajularipin bin Sulaiman[1], Sun He[3], Zulkifli bin Mohamad[4]

[1] Faculty of Educational Studies, Universiti Putra Malaysia, Serdang, 43400, Selangor, Malaysia, [2] Yun Cheng University, Shan xi Province, China, [3] School of Physical Education, Zhengzhou University, China, [4] Center for General Studies, Universiti Kebangsaan Malaysia, Bangi, 43600, Selangor, Malaysia

Email: 360284626@qq.com

Corresponding Author Email: samsilah@upm.edu.my

To Link this Article: http://dx.doi.org/10.6007/IJARPED/v12-i4/19879 DOI:10.6007/IJARPED/v12-i4/19879

Published Online: 06 December 2023

Abstract

Teaching Higher-Order Thinking Skills (HOTS) in Constructivist Smart Learning Environments (CSLE) has been treated as an essential goal of higher education in many countries. With new roles and functions in smart classrooms, learners' factors influencing teaching HOTS are very different from traditional classrooms. Although some cognitive and motivational factors always play an important role in teaching HOTS in CSLE, the lack of useful information and knowledge has caused many teachers to fail to teach HOTS effectively in smart classrooms in China. Based on previous research and related theories,this study aims to propose a framework of constructivist smart learning environments integrating cognitive and motivational factors for teaching higher-order thinking skills The results of this study were expected to contribute some effective guidance for teaching HOTS in constructivist smart learning environments among pre-service teachers in China.

Keywords: Higher-Order Thinking Skills, Constructivist Smart Learning Environments, Cognitive Strategies ,Goal Orientations

Introduction

Higher-Order Thinking Skills

learning and working in the 21st century with the highly competitive global "knowledge economy", students and employees can no longer survive by memorizing textbooks, they must learn to use "21st-century skills" to analyze, synthesize, and evaluate huge amounts of facts and information in everyday life, and solve problems effectively(Pithers & Soden, 2016). Higher-order thinking skills (HOTS) embodying critical thinking skills, problem-solving skills,

and creative thinking skills have been treated as essential skills for students to work and learn in the 21st Century (Marwan et al., 2021).

These skills have become an important part of many international competency models (Preus, 2012). Especially for student teachers who are future teachers in higher education, it is particularly important to cultivate and develop their critical thinking skills(Puig et al., 2020). China has focused more on cultivating students' HOTS in higher education (Ministry of Education 2021). In 2020, the Chinese Ministry of Education issued "The Implementation of Outstanding Teacher Training Plan 2.0 ", which clearly stated "After five years of efforts, we will cultivate a group of high-level, high-quality pre-service teachers" with HOTS, which indicated that teaching HOTS among pre-service teachers has become especially urgent and valued in China (li, 2021).

Constructivist Smart Learning Environments

Initially, integrating information technology into the classroom is a common method to improve learners' HOTS by changing the external environment(Venkatraman et al., 2022). In 2017, the EDUCAUSE Center for Analysis and Research identified technology-enabled learning environments as a strategic investment for colleges and universities, and recently year, smart classrooms have gained attention worldwide (Venkatraman et al., 2022). A constructivist smart learning environment is a learner-centered environment that attaches importance to students' actively subjective role in learning and their ability to construct knowledge independently (Rosmansyah et al., 2022). It combines the physical and virtual environments and integrates advanced forms of educational technology to support easy, engaged, and effective learning (3E) at any time, anywhere, in any way, and at any pace (4A) (Agbo et al., 2019; Murthy et al., 2016; Spector, 2014).

Previous studies have also indicated that the smart classroom environment can stimulate students' learning motivation, promote active learning, and improve academic performance (Lu, Yang, et al., 2021b). The smart classroom is founded on constructivist epistemology, which has become a well-recognized basis of a high-quality pedagogical approach (MacLeod et al., 2018). Constructivist pedagogy focuses on students developing their understanding of knowledge via social interactions in a learning environment (MacLeod et al., 2018). Such an approach has been shown to result in more diverse student learning and to improve students' HOTS when compared to traditional settings (MacLeod et al., 2018). Currently, smart learning classrooms are supposed could play positive roles in the development of students' HOTS and have become more and more popularized in higher education institutions in China (Hu, 2022; Zhang et al., 2021).

However, recently, some studies have shown that the HOTS level of college students including preservice teachers in China is still in the middle (Xia,2021) which indicates that attempts to teach HOTS among preservice teachers have not been successful in China. With advanced functions and roles, a smart learning environment supports and encourages students to construct knowledge actively, autonomously, and independently, in which factors such as learning strategies and motivation could play important roles (Hu, 2022; Zhang et al., 2021). Teachers should integrate personal factors into the environment to achieve effective teaching of higher-order thinking skills.

The traditional learning environment is teacher-centered and teachers are accustomed to using a single lecture method to instill knowledge in students, and this "fill-in-the-blank" approach tends to ignore the effect of students' factors on learning (Gao, Xie & Zhang,2022). As a result, many teachers lack new teaching experience and knowledge in the transition from

a traditional to a constructivist smart learning environment, which makes them fail to teach higher-order thinking skills effectively (Gao, Xie & Zhang,2022). Until now, teaching higher-order thinking skills in smart classrooms has been at a rudimentary and exploratory stage, and it urgently needs some relevant theory and information to guide in China (Liu, Wu &Jiang, 2020).

Many of the thinking intervention studies have shed light on the importance of learning environment, motivation, and cognitive factors during the process of learners' information processing (Kwan & Wong, 2015)), which in turn generated various learning outcomes, including some high-level thinking. Pintrich and Schrauben (1992) pointed out that students' learning outcomes in the classroom can be mainly accounted for by their motivational and cognitive factors (Kwan & Wong, 2015).

Cognitive Strategies

Cognitive strategies are usually defined as an individual's information processing to remember, transform, retrieve, and apply knowledge (Kwan & Wong, 2015). The basic cognitive strategies include rehearsal strategies, elaboration strategies, and organization strategies (Kwan & Wong, 2015). Metacognitive strategies refer to processes of operating cognitive processes in a self-monitoring manner (Kwan & Wong, 2015; Li et al., 2019; MacLeod et al., 2018). The study by Zohar (1994) implied that different learning environments together with students' cognitive strategies would have different effects on students' thinking outcomes (Kwan & Wong, 2015). The ''faster learners'' seem to have better improvements in high-level thinking skills in a constructivist learning environment as it encourages students to actively make full use of some high-level cognitive strategies and metacognitive strategies to complete learning tasks (Chen et al., 2022).

Goal Orientations

Goal orientation is the motivation for individuals to engage in achievement-related tasks that is a dynamic factor for individuals to work hard on things that they view are important and valuable (Pintrich, 2000). It is an individual belief system about the purpose of achievement activities, the significance of success, and the integration of success standards, which reflects an internal cognitive orientation of achievement tasks (Pintrich, 2000). Learners with different goal orientations always show different characteristics in cognition, emotion, and behavior of learning (Vandewalle & Nerstad, 2019). There are many studies have shown that goal orientations are good predictors of students' learning strategies, learning engagement, learning self-efficacy, and learning performance in different learning environments (Pintrich,2000; Vandewalle& Nerstad, 2021).

Hence, it is very necessary to explore and assess the mechanism of the role of cognitive strategies and goal orientations in teaching of higher-order thinking skills in the constructivist smart learning environment. This study will extend previous research and fill the research gaps to propose a framework of constructivist smart learning environments integrating cognitive and motivational factors for teaching higher-order thinking skills with the expectation of contributing some effective guidance for teaching HOTS among pre-service teachers in China.

Framework For Teaching Hots In Csle

Gibson invented the word "affordance" to reveal the relationship between the environment and the organism in ecological psychology. According to Gibson organisms can be defined as

actors which are perceiving and behaving in the environment (Gibson, 1986), while affordances mean the possibilities and opportunities that the environments afford actors to make some available perceptions and actions to achieve some special goals (Oliver, 2005). In this sense, affordance is a term that relates to both the environment and the organism, emphasizing that the organism and the environment are an inseparable unity. It introduces the idea of actor-environment mutuality which means that the environment influences and constrains the actions of the organism, while the organism determines the properties of the environment (Gibson, 1986).

Gibson argued that affordances always have specific properties and effects that are associated with the perceptions and actions of organisms, and these properties and effects can only be actualized and achieved through the perception and utilization by organisms (Kordt, 2018a). Following Gibson, affordances theory has received more and more attention, been introduced into different disciplinary fields, and been developed further by some scholars (Lainema et al., 2021).

Some studies have found that organisms' needs and goal orientations influence their perceptions and actions of affordances (Kordt, 2018b; Pozzi et al., 2014a), and that matching the properties and effects of affordances with organisms' needs and goals is conducive to effective perceptions and behaviors, ultimately enabling the effects of affordance to be achieved (Bernhard et al., 2013; Pozzi et al., 2014b). In recent years, it has also found application in Education (Lainema et al.2020; li&wu2016; Wang et al., 2020). Young introduced the concept of effectivity from an ecopsychological perspective, he argued that effectivity refers to an individual's ability to take action (the ability to perceive and make use of affordances) (C.Wang et al., 2020), and affordances are properties of the environment that enables individual to take some effective actions (Young et al., 2000).

According to Young (2000), the learning environment provides affordances for learner's behaviors and thinking, and the learners act on the environment through their effectivity (Churchill,2008; Kordt,2018a), however, in this process, the learner's intentions and goals always influence how he or she perceives and utilizes affordances (Jenkins, 2008; Oliver, 2005; C. Wang et al., 2020), which means that the learning environment provides the learners with opportunities and possibilities for certain learning activities, but how these opportunities and possibilities are perceived and utilized by the learners is closely related to the learner's intentions and goals (Kordt, 2018b; Park & Song, 2015; Pozzi et al., 2014b; C. Wang et al., 2020).

In short, Gibson's (1986) affordance theory of Ecological psychology introduced the idea of actor-environment mutuality in which affordance is the result of the interaction between the environment and the organism. Organisms are defined as actors which are perceiving and behaving in the environment (Gibson,1986), while affordances mean the possibilities and opportunities the environments afford actors to achieve some specific goals (Oliver, 2005). however, Gibson argued that the affordances need to be perceived and actualized by the organism(actors) so that the properties and effects can be achieved (Kordt, 2018a) furthermore, it is emphasized that actors' perception and actualization of affordances a goal-oriented process that could further determine the effects of the affordances (Kordt, 2018b; Pozzi et al., 2014b).

Based on the affordance theory, this study conducted the theoretical framework that is shown as Figure 1. In this framework, the affordances are the results of the interaction between constructivist smart learning environments (CSLE) and learners that mainly involves student negotiation (SN), inquiry learning (IL), reflective thinking (RT), ease of use (EOU),

perceived usefulness(PU), multiple sources(MS), connectedness(CN)and functional design(FD). These affordances could provide opportunities and possibilities for students to engage in some high-level learning activities (G. J. Hwang, 2014; Yang, 2018). However, it needs students to adopt corresponding cognitive strategies to recognize and actualize the affordances, and meanwhile, this process is always driven by goal orientations which would further infuluence the achievement of the affordance's effects on developing the HOTS.

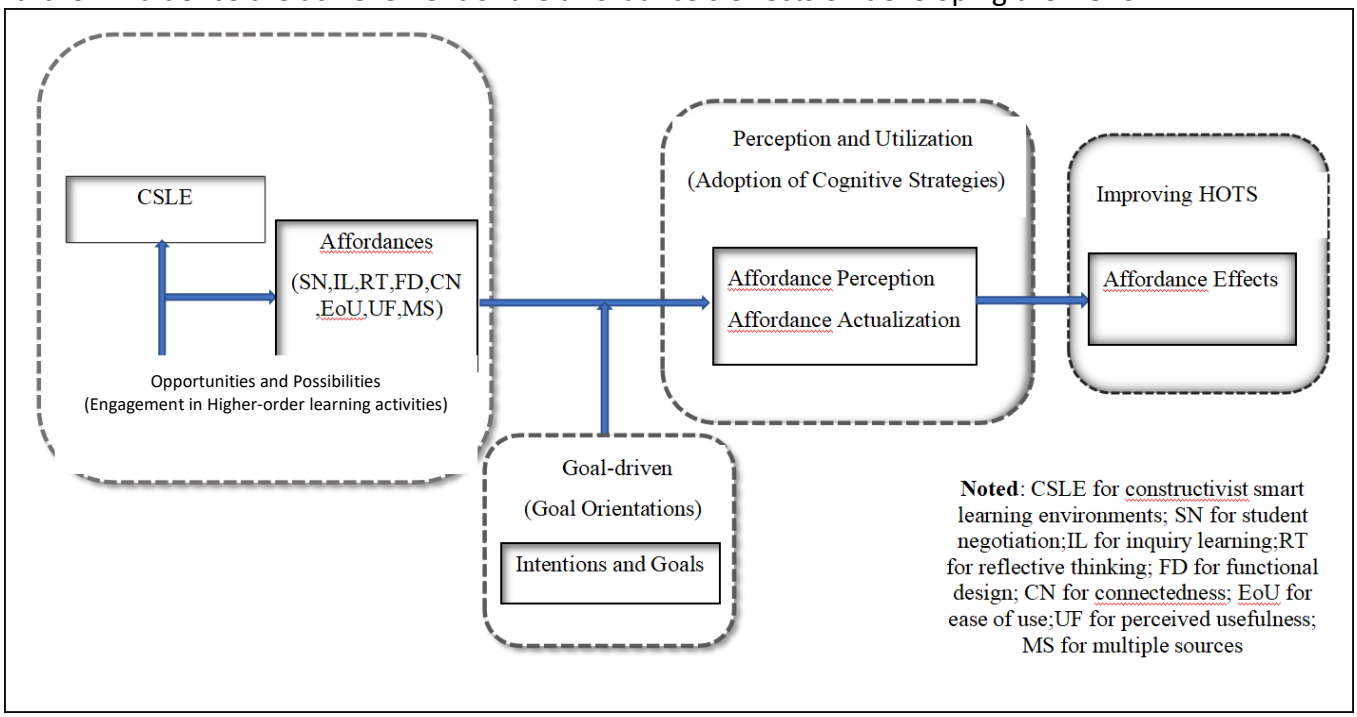

Figure1: Tramework For teaching HOTS in CSLE

Discussion

The Components of CSLE support the development of HOTS

Based on Gibson's (1986) affordance theory, as affordances of constructivist smart learning environments(CSLE), the eight components of student negotiation(SN), inquiry learning(IL), reflective thinking(RT), ease of use (EOU), perceived usefulness(PU), multiple sources(MS), connectedness(CN)and functional design(FD) have the advantage of providing learners with opportunities and possibilities to develop and upgrade their higher-order thinking skills. This study tries to explain that as follows.

Student Negotiation and HOTS

According to the dialogue theory of Paulo(1958), negotiation is a kind of cooperative dialogue, which requires people to put aside their subjective ideas, so that they can carefully examine these ideas themselves. At the same time, people should listen carefully to other people's ideas and put them on hold, and further analyze, synthesize, and evaluate these ideas repeatedly, to find out the true meaning of all these ideas and achieve consensus and win-win (Page & Mukherjee, 2007).

In constructivist smart learning environments, student negotiation is a process of cooperative learning, in which students discuss topics together as equals. They understand and care about each other, integrate their opinions, and complete learning tasks together. This kind of cooperative learning dialogue requires students to shelve their thinking assumptions and

judgments and seriously consider their opinions from the perspective of others to encourage students to reflect on their knowledge, restructuring, and creation.

To sum up, ' negotiated dialogue ' is a constructive way of thinking. First of all, it requires students to listen to the information spoken by others and analyze their argumentation logic. Secondly, students reflect on their judgments and arguments based on listening, enrich their knowledge with others ' viewpoints, and then reconstruct meaning and convey meaning. These requirements are very consistent with the quality of higher-order thinking skills.

Inquiry Learning and HOTS

According to Kauchak and Eggen (1998), inquiry was a process of posing problems, gathering information, using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions(Jumilah et al., 2021); and communicating the results; thinking creatively about possibilities, making decisions and justifying conclusions. (Khan & O'Rourke,2015). It is particularly valuable for giving students practice in defining problems, gathering data to solve the problems, and developing their higher-order thinking abilities(Yulianti et al., 2018). Previous research found that inquiry learning enhances students' learning achievement, especially in the aspects of problem-solving skills, ability to explain data, critical thinking, and understanding of concepts in learning science(Chiappetta &Russel,2019; Saunders & Shepardson,2020).

In the constructivist smart learning environments, "inquiry-based learning is a student-centered, active learning approach focused on questioning, critical thinking, and problem-solving. Inquiry-based learning activities begin with a question followed by investigating solutions, creating new knowledge as information is gathered and understood, discussing discoveries and experiences, and reflecting on new-found knowledge." In conclusion, inquiry-based learning is a learner-centered teaching approach that emphasizes deep learning. It may take several forms, including analysis, reflecting on new-found knowledge, problem-solving, discovery, and creating activities that will be conducive to the development of students' high-order thinking skills.

Reflection and higher-order thinking skills

Dewey (1910) first put forward the concept of reflective thinking, he believes that one of the best ways of thinking is reflection and the methods and processes of reflective thinking are mainly ' identifying problems, collecting and analyzing data, putting forward hypotheses, verifying hypotheses, and drawing conclusions(Mete, 2020). Zheng (2018) and Wu et al. (2019) define reflective learning as a learning activity in which learners consciously and critically examine their own cognitive structure, learning activities, and related factors involved, creatively foresee the learning activities to be carried out, scientifically explore the problems found in the process of learning activities, and effectively regulate the whole process of learning activities, to promote problem-solving.

In the smart learning environment, learners have strong reflective ability and regular reflective consciousness. They will reflect on their learning process and results, to effectively solve the problems existing in the learning process, realize the monitoring, adjustment, remedy, and improvement of their learning, promote the understanding, application, and transfer of knowledge, and finally realize high-level learning(García-Tudela et al., 2020). Through positive and effective reflection, learners can re-understand and re-evaluate themselves and get newer self-experience (Marzano et al., 2021). Many studies have shown that reflective learning is inquiry, critical, and innovative. In short, reflection will run through

the whole process of higher-order thinking development, and it is an effective way to promote the achievement of higher-order thinking goals(Gambo & Shakir, 2019).

Function design and higher-order thinking skills

According to the awakening view of environmental psychology, environmental stimulation will awaken people's psychological or behavioral responses to a certain extent, while positive and appropriate environmental stimulation will improve people's work quality and efficiency (Honebein,1999). The function design of a constructivist smart learning environment is centered on students' needs from the aspects of space area, desk and chair design, space temperature, green plants, and space planning (liu,2010). These characteristics of spatial environment elements can awaken students' learning participation emotions, improve students' attitudes, and increase their learning input to a certain extent (Zong & Hung,2019). In addition, the smart classroom is equipped with touch all-in-one machines, electronic whiteboards, handheld iPads for teachers, and touch all-in-one machines and mobile phone terminal screens for students' groups(Freigang et al., 2018). These devices can effectively support teachers and students to carry out quick intelligent terminal interaction, resource sharing, and data transmission interaction, thus enhancing students' learning depth and breadth(Freigang et al., 2018).

Connectedness and higher-order thinking skills

Compared with the simple multimedia teaching environment, the smart classroom has rich types of efficient teaching interactions. In a smart classroom, teachers and students fully display and share their thinking processes and learning outcomes with the help of advanced technology, which can effectively promote the interaction and collision of students' thinking, forming a multiple-interaction model of students' self-reflection, peer interaction, and teacher-student interaction(J. Wang et al., 2022). In the process of interacting with teachers and peers, students can effectively enhance their motivation to learn, stay focused, and maintain classroom participation, which in turn stimulates them to think deeply about learning(Hu, 2022).

In the smart classroom environment, advanced technology and equipment provide diversified ways for "student-student" and "teacher-student" emotional interaction, which creates a good learning atmosphere and interpersonal environment for teachers and students(Sousa-Vieira et al., 2022). This transformation will facilitate high-level and personalized learning for students. In short, in the constructivist smart classroom, the advantages of convenient interactive ways, equal interactive relations, deep interactive effects, and high interactive participation provide strong support for students to engage in effective higher-level learning.

Ease of use, Perceived usefulness, and higher-order thinking skills

TAM (Technology Acceptance Model) theory was put forward by Davis in 1989 based on the rational behavior theory. According to TAM theory, the attitude of use is the subjective evaluation of student's participation in learning activities in smart classrooms, while perceived ease of use and perceived usefulness are the important factors of students' attitudes towards participating in smart classrooms (Jiang et al., 2022). Perceived ease of use refers to the degree of physical and mental difficulty that students feel in participating in learning activities in a smart classroom (Han, 2019). Venkatesh et al. (2020) argued that students are very concerned about the ease of online learning and class discussion sessions

in the smart classroom. Wu et al (2018) stated that perceived ease of use is one of the important prerequisites for determining perceived usefulness.

Perceived usefulness refers to the effectiveness of the smart classroom in enhancing learning outcomes. Wang, et al. (2021) found that college students are more concerned about the practical utility of smart classroom teaching for their learning. If college students perceive the practical effects of smart classrooms strongly, they will significantly increase their participation and learning engagement in smart classrooms, which could in turn enhance their higher-order learning(Petrovie et al., 2022).

Loughlin et al. (2020) found that through careful design, all elements in the classroom can enhance the learning experience and strengthen the desire to learn. A smart classroom is a virtual-real mixed classroom environment that combines advanced technologies and media devices making smart classrooms socialized, intelligent, interactive, flexible, and adaptable (Zhang, 2021). In a smart classroom, teachers are more capable of supervising, guiding, and assessing students, and can provide timely feedback to students when necessary to escort higher-order learning(Edwards et al., 2020); students are more capable of engaging in formal learning, and their interest and motivation will be stimulated and creativity will be mobilized, which can efficiently facilitate the development of higher-order thinking skills (Zhu &Peng, 2019).

Multiple Sources and higher-order thinking skills

Rich and diverse learning resources help learners complete tasks, promote knowledge construction, and improve thinking ability(Kasperiuniene & Tandzegolskiene, 2020).

Smart classroom learning resources have the following advantages(Gambo & Shakir, 2021): 1. Diversity, it can fully characterize the complexity of the ' 4S ' knowledge structure, while meeting the individual needs of learners' multi-sensory channel. 2. Mobility, Learning resources are not static, but change dynamically with the advancement of the main clue of cognitive process, which effectively supports the development of learners ' cognitive process. 3. Sharing, each learner can not only have their personalized learning resources but also can cooperate with other learners and share resources, which improves the utilization of learning resources and learning effectiveness.4. Interaction, in the process of sharing learning resources, there are rich interactive behaviors between man-machine, teacher-student and student-student, including knowledge transfer, thinking collision, emotional communication, inspiration and other processes, which greatly promote students ' higher-order learning.5.Contextuality, learning resources can be close to the real problem situation greatest extent to effectively promote the development of learners ' problem-solving ability (Gambo & Shakir, 2021).

The rich and diversified learning resources in the smart learning environment promote cooperation and joint efforts among learners. Through the understanding and perception of diversified learning resources and the criticism and reflection on the existing knowledge and experience, learners further create new ideas, methods, and problem-solving strategies, so as to effectively develop and improve higher-order thinking skills.

Cognitive Strategies play the mediateing role in teaching HOTS in CSLE

Cognitive strategies are not only a variety of information processing methods adopted by learners to complete learning tasks, but also an internal information processing skill organized by learners to regulate their own learning and thinking activities (Puig et al., 2020). According to the theories of cognition, cognitive strategies are mainly divided into rehearsal strategies,

elaboration strategies, and organization strategies (Pintrich, 1985). Rehearsal strategy refers to the method of using internal language to reproduce learning materials or stimuli in the brain to keep information in working memory, and to keep attention on learning materials (liu,1998).

Elaboration strategies refer to deep processing strategies that link new information with old information in the mind to increase the meaning of new information (Pintrich, 1985). It is often described as a strategy for understanding memory, whose essence is to make connections between information (Chen,2006). The more connections you have, the more ways you can recall the original information, that is, the more clues you can extract and the deeper and more detailed the finishing, the easier it is to recall (wu,2001). Elaborate processing strategies include telling the general idea, summarizing, building analogy, taking notes in one's own words, explaining, asking questions, and answering questions (wang,2002).

Organization strategy is a higher-level information processing strategy that constructs the refined knowledge points to form a knowledge structure (Al-Qaysi et al., 2021). There are two main organizational strategies: one is the categorization strategy, which is used to categorize and organize knowledge such as concepts, words, and rules; the other is the outline strategy, which is mainly used to grasp the structure of learning materials (Nurfadilah et al., 2020).

The main functions of cognitive strategies include two aspects: first, to identify and encode the information input from the outside world, and then process and organize it effectively; second, systematically store the processed information and classify it reasonably (Pambudi et al., 2022).

metacognitive strategies are a series of high-level psychological activities with executive functions and can be applied to different learning activities. They are the cognition of cognition and are mainly used to evaluate, manage, and monitor the use of cognitive strategies(Price & Reus-Smit, 1998). It is generally believed that metacognitive strategies can be divided into three types (liu, 1997).

The first one is planning strategy, which refers to planning various activities before a cognitive activity, predicting the results, choosing strategies, figuring out various solutions to problems, and predicting their effectiveness, including setting learning objectives, browsing reading materials, and analyzing how to complete learning tasks. The second one is the monitoring strategy, which means that in the actual process of cognitive activities, timely evaluation and feedback of the results and deficiencies of one's cognitive activities according to cognitive goals, and correctly estimate the degree and level of one's achievement of cognitive goals; criteria evaluate the effects of various cognitive activities and strategies, including tracking attention, self-questioning of material, and monitoring one's speed and time; the third one is the regulating strategy, which refers to taking corresponding remedial measures to modify and regulate the cognitive strategy timely according to the results of the examination of cognitive activities (Evcim & Arslan, 2021; Zach & Ophir, 2020).

Cognitive strategies play a pivotal role in enabling students to regulate their entire learning process, enhance their learning initiative, and ultimately improve their learning effectiveness (Badie, 2018); the acquisition of metacognitive strategies empowers students to comprehend, select, and monitor the strategies they have learned, thereby enhancing the effectiveness of their learning (Xie &Zhang, 2022). It is evident that cognitive strategies and metacognitive strategies exhibit a significant positive correlation with students' academic performance in smart learning environments (Wei & Nelson, 2019).

These affordances in the smart learning environment could provide opportunities and possibilities for students to engage in some high-level learning activities so as to develop their high-order thinking skills. However, the affordances need to be perceived and actualized by learners so that the properties and effects of promoting the development of HOTS can be achieved (Xun & Wu,2019).

Considering the essential characteristics and functions of cognitive strategies and metacognitive strategies, it is reasonable to assume that the process of learners' perception and utilization of affordances involves the process of taking appropriate cognitive strategies to process and construct the information and stimuli related to affordances, accordingly, we can propose that cognitive strategies play the mediating role within high-order thinking skills and the smart learning environment.

For example, when students recognize and actualize the affordances of student negotiation, they adopt elaborate processing strategies and organization strategies to compare different viewpoints, summarize their strengths and weaknesses, extract valuable information for reference, establish a connection between new knowledge and existing old knowledge, and further assign new explanations to new information, which can effectively develop and enhance learners ' critical thinking skills and creative thinking skills.

In the process of Perceiving and actualizing the inquiry learning, students need to make full use of elaborate processing strategies, organizational strategies, and metacognitive strategies in every stage of finding problems, collecting materials, clarifying problems, establishing hypotheses, verifying hypotheses and acquiring new knowledge, which makes their problem-solving thinking skills, critical thinking skills, and creative thinking skills effectively developed

The process of reflection involved planning and guiding the upcoming learning activities, monitoring and adjusting the ongoing learning activities, and summarizing and evaluating the learning results that need learners to adopt some high-level cognitive strategies such as elaborate processing strategies, organizational strategies, and metacognitive strategies to actualize that would promote the development of their problem-solving thinking skills, critical thinking skills, and creative thinking skills to a certain extent improved.

In short, in the process of actualizing the affordances in smart classrooms, learners need to adopt some high-level cognitive strategies to critique and reflect on their existing knowledge and experience, and further create new ideas, methods, and problem-solving strategies, thus effectively developing and enhancing their higher-order thinking skills.

Goal Orientations could enhance the achievements of teaching HOTS in CSLE through Cognitive Strategies

According to the affordances theory, the organism's perception and actions toward affordances are goal-driven processes. By integrating the properties of affordances with their needs and goals, individuals can perceive and act upon these affordances more effectively and fully. Ultimately, this maximizes the positive effect of affordances on individuals' achievements (Kordt, 2018b; Park & Song, 2015; Pozzi et al., 2014b; C. Wang et al., 2020).

Young(2000) argued that the learning environment provides affordances for learner's behaviors and thinking, and the learners act on the environment through their effectivity (Churchill,2008; Kordt,2018a) always influenced by the learner's intentions and goals (Jenkins, 2008; Oliver, 2005; C. Wang et al., 2020), which means the extent to which learners perceive and utilize these opportunities and possibilities depends on their intentions and goals. The organism's needs and goal orientations would influence its perception and actions toward the affordances present in its environment (Kordt, 2018b; Pozzi et al., 2014a).

Hence, Affordances in the constructivist smart learning environment need learner' to recognize and actualize to achieve the effects of developing HOTS, however, goal orientations always enhance students' adoption of cognitive strategies to recognize and actualize the affordances which can further determines the achievement of the affordances' effects on developing the HOTS

Goal orientation refers to the motivation for individuals to engage in an achievement-related task which can explain individuals' cognitive judgment and value judgment of achievement motivation (Kaspi-Baruch,2019). M.L. Mehr (1998) defined it as an individual's perception of the reasons for engaging in various achievement activities and they believe that achievement goal is an intrinsic trait of individuals who strive to show their abilities and make their actions more effective(He et al., 2016).

According to Pintrich et al(1998), goal orientation can be divided into intrinsic goal orientations(challenge, curiosity, mastery) and extrinsic goal orientations (grades, rewards, performance). Learners with different goal orientations always show different characteristics in cognition, emotion, and behavior of learning (Dweck, 1992). Students with intrinsic goal orientations always attach importance to the development and progress of their abilities (Lefran, 2000), maintain a positive emotional state (Gopalan et al. 2017), and prefer to choose challenging tasks, using more deep processing strategies and make continuous efforts (nie&shen,2008; Chen,2009); while students with extrinsic goal orientations always pay more attention to show good performance (liu&wang,2009) hold negative emotions such as anxiety and shame when facing failure (Chen,2009) and more likely to choose low-effort tasks, use more superficial strategies that are easier to succeed (nie&shen,2008; Chen, 2009; Ames & Archer, 1988; Meece, Anderman, 2006).

The existing research findings consistently show that in the process of learning and mastering the achievement task, individuals who accept the mastery goal orientation use more deep processing strategies such as integration and reorganization, and can effectively use self-regulating learning strategies such as planning, management, and monitoring, while performance-oriented students tend to adopt simple processing strategies such as recitation and simple retelling which have a quick effect on their academic result (liu,2022).

Hence, considering the positive association of goal orientation with cognitive strategies, it is reasonable to assume that goal orientation, especially internal goal orientation, can enhance students' use of high-level cognitive strategies, thus further improving higher-order thinking skills in the constructivist smart learning environment.

For example, when students recognize and actualize the affordances of student negotiation in the constructivist smart learning environment, intrinsic goal orientations could make them maintain a positive and confident emotional state and enhance their adopting of high-level learning strategies to analyze and question others ‘views, put forward open questions worthy of discussion, or respond to others’ questions with arguments and explanations to supplement others' views (Telaumbanua et al., 2019) so as to construct and create high-level cognitive structure and develop their HOTS.

Inquiry learning in a constructivist smart learning environment values students' autonomous learning and encourages students to complete some complex tasks and goals that stimulate learners to use some high-level cognitive strategies, during the process, students with goal orientations such as challenging themselves and developing abilities would make their best efforts to actively adopt various deep learning strategies(Lefranc¸ois, 2020) to identify problems, collect information, solve problems and construct higher-order knowledge so as to develop HOTS.

Reflection of a constructivist smart learning environment always requires learners to creatively anticipate the learning activities, effectively monitor and regulate the learning process, and evaluate and summarize the learning outcomes, thus achieving good performance and self-development (Afifah & Azizah, 2021). Goal orientations could enhance students' engagement in using different cognitive especially metacognitive strategies to conduct effective reflection to promote their development of HOTS.

To summarize, specific tasks and goals in the constructivist smart learning environment require and motivate learners to employ various cognitive strategies. Throughout this process, goal orientation plays a crucial role in reinforcing students' engagement in higher-order learning activities and motivating them to improve their utilization of cognitive strategies to a higher level. This heightened engagement and utilization of high-level cognitive strategies contribute to the successful completion of complex tasks that are catalysts for the development of higher-order thinking skills. Therefore, goal orientation plays a significant role in enhancing the positive effects of on the development of cognitive strategies and indirectly strengthens the development of students' higher-order thinking skills.

Conclusion And Recommendations

In constructivist smart learning environments, affordances such as student negotiation(SN), inquiry learning(IL), reflective thinking(RT), ease of use (EOU), perceived usefulness(PU), multiple sources(MS), connectedness(CN)and functional design(FD) have some attributes and functions that contribute to the development of higher-order thinking skills among Chinese pre-service teachers.

These affordances provide students with opportunities and possibilities to engage in higher-order learning activities and motivate learners to employ various cognitive strategies especially some high-level cognitive strategies to engage in some complex or in-depth learning activities, ultimately leading to the development of higher-order thinking skills.

Moreover, students' adopting of various cognitive strategies to engage in some complex or high-level learning activities is intrinsically tied to learners' intentions and goals, underscoring the goal-driven nature of the process. Hence learners' intentions and goals significantly influence the strength of their perception and utilization of the available affordances. Goal orientations catalyze students' improvement of cognitive strategies and maximize the development of higher-order thinking skills.

In the constructivist smart environment, teachers should leverage the affordances of inquiry learning, reflective thinking, and perceived usefulness to create a conducive learning environment that fosters learners' adoption of high-level cognitive strategies and engagement in complex learning tasks.

Teachers should play a vital role and attach importance to the cultivation and development of pre-service teachers' goal orientations through various strategies within the context of inquiry learning in order to improve their higher-order thinking skills. By incorporating in-depth learning tasks, flexible learning processes, and open and creative learning outcomes assessment, teachers could effectively develop and enhance pre-service teachers' goal orientations within inquiry learning. This approach promotes intrinsic motivation, fosters higher-order thinking skills, and prepares pre-service teachers to become lifelong learners who are capable of setting and achieving meaningful goals in their future teaching careers.

References

Al-Maroof, R. S., Alhumaid, K., & Salloum, S. (2021). The continuous intention to use e-learning, from two different perspectives. *Education Sciences*, *11*(1). https://doi.org/10.3390/educsci11010006

Alamri, M. M., Almaiah, M. A., & Al-Rahmi, W. M. (2020). Social media applications affecting students' academic performance: A model developed for sustainability in higher education. *Sustainability (Switzerland)*, *12*(16). https://doi.org/10.3390/su12166471

Abdullah, F., & Ward, R. (2016). Developing a General Extended Technology Acceptance Model for E-Learning (GETAMEL) by analysing commonly used external factors. *Computers in Human Behavior*, *56*. https://doi.org/10.1016/j.chb.2015.11.036

Agbo, F. J., Oyelere, S. S., & Bouali, N. (2020). A UML approach for designing a VR-based smart learning environment for programming education. 2020 IEEE Frontiers in Education Conference (FIE)

Antonio, R. P. J. I. J. o. R. i. E., & Science. (2020). Developing Students' Reflective Thinking Skills in a Metacognitive and Argument-Driven Learning Environment. *6*(3), 467-483.

Avcı, Ü. (2022). A predictive analysis of learning motivation and reflective thinking skills on computer programming achievement. *Computer Applications in Engineering Education*, *30*(4). https://doi.org/ https://doi.org/10.1002/cae.22505

Bautista Pérez, G., Rubio Hurtado, M. J., & Sánchez-Martí, A. J. L. E. R. (2022). Towards smart learning spaces in Catalan schools: teachers' perceptions of change. 1-17.

Bertagnolli, C. (2011). Delle Vicende Dell'agricoltura in Italia; Studio e Note Di C. *Bertagnolli.*, *13*(3). Bayram, Z., Oskay, Ö. Ö., Erdem, E., Özgür, S. D., & Şen, Ş. (2013). Effect of Inquiry based Learning Method on Students' Motivation. *Procedia - Social and Behavioral Sciences*, *106*, 988–996. https://doi.org/10.1016/j.sbspro.2013.12.112

Borovay, L. A., Shore, B. M., Caccese, C., Yang, E., & Hua, O. (Liv). (2019). Flow, Achievement Level, and Inquiry-Based Learning. *Journal of Advanced Academics*, *30*(1), 74–106. https://doi.org/10.1177/1932202X18809659

Charania, A., Bakshani, U., Paltiwale, S., Kaur, I., & Nasrin, N. (2021). Constructivist teaching and learning with technologies in the COVID-19 lockdown in Eastern India. *British Journal of Educational Technology*, *52*(4). https://doi.org/10.1111/bjet.13111

Cansoy, R., & Turkoglu, M. E. (2017). Examining the Relationship between Pre-Service Teachers' Critical Thinking Disposition, Problem Solving Skills and Teacher Self-Efficacy. *International Education Studies*, *10*(6), 23. https://doi.org/10.5539/ies.v10n6p23

Churchill, D., Churchill, N. J. C., & Education. (2008). Educational affordances of PDAs: A study of a teacher's exploration of this technology. *50*(4), 1439-1450.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly: Management Information Systems*, *13*(3). https://doi.org/https://doi.org/10.2307/249008

Dewi, D. K., Ardhana, W., Irtadji, Chusniyah, T., & Sulianti, A. (2021). Inquiry-based learning implementation to improve critical thinking of prospective teachers. *International Journal of Information and Education Technology*, *11*(12). https://doi.org/10.18178/IJIET.2021.11.12.1575

Elgeddawy, M. (2018). UNIVERSITY STUDENTS' ATTITUDE TOWARDS WEBQUEST: AN EMPIRICAL CORRELATIONAL STUDY. *IJASOS- International E-Journal of Advances in Social*

Sciences. https://doi.org/10.18769/ijasos.425351

Erdogan, F. (2019). Effect of cooperative learning supported by reflective thinking activities on students' critical thinking skills. *Eurasian Journal of Educational Research*, *2019*(80), 89–112. https://doi.org/10.14689/ejer.2019.80.5

Edwards, M., Kerevel, Y., & Hultquist, P. (2020). Do simulations improve higher-order learning outcomes? Evaluating student learning through a simulated regional trade agreement negotiation.

Fadilah, F. D., Ridwan, N. M., Putri, N. D., Prayoga, S., & Ihsan, M. T. J. J. R. d. I. P. (2021). THE ROLE OF METACOGNITION STRATEGY TO ENHANCE READING COMPREHENSION. *1*(3), Feyzioğlu, B. (2019). The role of inquiry-based self-efficacy, achievement goal orientation, and learning strategies on secondary-school students' inquiry skills. *Research in Science and Technological Education*, *37*(3), 366–392. https://doi.org/10.1080/02635143.2019.1579187206-213.

Gambo, Y., & Shakir, M. Z. (2021). Review on self-regulated learning in smart learning environment. In *Smart Learning Environments* (Vol. 8, Issue 1). https://doi.org/10.1186/s40561-021-00157-8

Gambo, Y., & Shakir, M. Z. . (2019). New development and evaluation model for self-regulated smart learning environment in higher education. *IEEE Global EngineeringEducationConference,EDUCON,*. https://doi.org/https://doi.org/10.1109/

Gao, X., & Zhang. (2022). A study on the intervention strategy system of higher-order thinking development in the perspective of smart classroom. *China ElectroChemicalEducation*, *(06),112119+133*. https://kns.cnki.net/kcms2/article/abstract?v=3uoqIhG8C44YLTlOAiTRKibYlV5Vjs7iJTKGjg9uTdeTsOI_ra5_Xdd_d8k8l6tz0z5txX9jBfgyxFyCreMz6yoPEdDfzAcC&uniplatform=NZKPT&src=copy

Garcia, C. G., & Hooper, H. H. . (2009). Developing students' critical thinking in Hong Kong secondary school english writing classes. *RELCJournal*, *40*(3), From policies to realities. https://doi.org/doi.org/10.1177/0033688209343866

Gibson, J. J. J. C. E. T. T. o. A. (1986). Gibson theory of affordances. Pdf. 127-136.

Greenberger, S. W. J. R. P. (2020). Creating a guide for reflective practice: applying Dewey's reflective thinking to document faculty scholarly engagement. *21*(4), 458-472.

Honicke, T., Broadbent, J., Fuller-Tyszkiewicz, M. J. H. E. R., & Development. (2020). Learner self-efficacy, goal orientation, and academic achievement: exploring mediating and moderating relationships. *39*(4), 689-703.

Hu, Y.-H. J. E., & Technologies, I. (2022). Effects and acceptance of precision education in an AI-supported smart learning environment. *27*(2), 2013-2037.

Huang, R., Yang, J., & Zheng, L. (2013). The Components and Functions of Smart Learning Environments for Easy, Engaged and Effective Learning The Demands on Rebuilding Learning Environments in Information Society. *International Journal for Educational Media and Technology*, *7*(1), 4–14.

Hamzah, H., Hamzah, M. I., & Zulkifli, H. (2022). Systematic Literature Review on the Elements of Metacognition-Based Higher Order Thinking Skills (HOTS) Teaching and Learning Modules. In *Sustainability (Switzerland)* (Vol. 14, Issue 2). https://doi.org/10.3390/su14020813

He, Y., Yao, X., Wang, S., & Caughron, J. (2016). Linking Failure Feedback to Individual Creativity: The Moderation Role of Goal Orientation. *Creativity Research Journal*, *28*(1), 52–59. https://doi.org/10.1080/10400419.2016.1125248

Ibnu, S., & Rahayu, S. J. E. J. o. E. R. (2020). The Effectiveness of New Inquiry-Based Learning (NIBL) for Improving Multiple Higher-Order Thinking Skills (M-HOTS) of Prospective Chemistry Teachers. *9*(3), 1309-1325.

Islam, T., Ahmad, S., Kaleem, A., & Mahmood, K. J. M. D. (2021). Abusive supervision and knowledge sharing: moderating roles of Islamic work ethic and learning goal orientation. *59*(2), 205-222.

Jia, Q. J. I. E. S. (2010). A brief study on the implication of constructivism teaching theory on classroom teaching reform in basic education. *3*(2), 197-199.

Jiang, F., Ma, X. Y., Zhang, Y. H., Wang, L., Cao, W. L., Li, J. X., & Tong, J. (2022). A new form of deep learning in smart logistics with IoT environment. *Journal of Supercomputing*, *78*(9). https://doi.org/10.1007/s11227-022-04343-4

Karaoglan-Yilmaz, F. G., Ustun, A. B., Zhang, K., & Yilmaz, R. (2023). METACOGNITIVE AWARENESS, REFLECTIVE THINKING, PROBLEM SOLVING, AND COMMUNITY OF INQUIRY AS PREDICTORS OF ACADEMIC SELF-EFFICACY IN BLENDED LEARNING: A CORRELATIONAL STUDY. *Turkish Online Journal of Distance Education*, *24*(1). https://doi.org/10.17718/tojde.989874

Kaiser, I., Mayer, J., & Malai, D. J. F. i. p. (2018). Self-generation in the context of inquiry-based learning. *9*, 2440.

Kaniaswari, R., & Suzianti, A. (2020). Theoretical Framework Design for Measuring Student's Preference towards Smart Learning Class. *ACM International Conference Proceeding Series*, 1–6. https://doi.org/10.1145/3400934.3400937

Kartono, A., Mariani, P. D., & Mariani, S. . (2019). Analysis of Students' Mathematical Reflective Thinking on Problem Based Learning (PBL) Based from Learning Styles. . *Unnes Journal of Mathematics Education*, *8*(1).

Kazhikenova, G., Zhumataeva, E., Kozhamzharova, M., & Aubakirova, S. (2021). The effectiveness of reflective dialogue in the development of reflective thinking in rising teachers. In *Thinking Skills and Creativity* (Vol. 41). https://doi.org/10.1016/j.tsc.2021.100902

Kaspi-Baruch, O. J. T. J. o. C. B. (2019). Big Five personality and creativity: the moderating effect of motivational goal orientation. *53*(3), 325-338.

King, R. B., & Areepattamannil, S. (2014). What students feel in school influences the strategies they use for learning: Academic emotions and cognitive/meta-cognitive strategies. *Journal of Pacific Rim Psychology*, *8*(1). https://doi.org/10.1017/prp.2014.3

Kholid, M. N., Sa'dijah, C., Hidayanto, E., & Permadi, H. (2020). How are students' reflective thinking for problem solving? *Journal for the Education of Gifted Young Scientists*, *8*(3). https://doi.org/10.17478/JEGYS.688210

Kordt, B. (2018). Affordance theory and multiple language learning and teaching. *International Journal of Multilingualism*, *15*(2). https://doi.org/10.1080/14790718.2016.1223081

Kang, J. (2022). Interrelationship Between Inquiry-Based Learning and Instructional Quality in Predicting Science Literacy. *Research in Science Education*, *52*(1). https://doi.org/10.1007/s11165-020-09946-6

Kwan, Y. W., & Wong, A. F. J. I. J. o. E. R. (2015). Effects of the constructivist learning environment on students' critical thinking ability: Cognitive and motivational variables as mediators. *70*, 68-79.

Kurdi, B. Al, Alshurideh, M., & Salloum, S. A. (2020). Investigating a theoretical framework for e-learning technology acceptance. *International Journal of Electrical and Computer Engineering*, *10*(6). https://doi.org/10.11591/IJECE.V10I6.PP6484-6496

Lu, K., Pang, F., & Shadiev, R. (2021). Understanding the mediating effect of learning approach between learning factors and higher order thinking skills in collaborative inquiry-based learning. *Educational Technology Research and Development*, *69*(5). https://doi.org/10.1007/s11423-021-10025-4

Lohbeck, A., & Moschner, B. (2022). Motivational regulation strategies, academic self-concept, and cognitive learning strategies of university students: does academic self-concept play an interactive role? *European Journal of Psychology of Education*, *37*(4). https://doi.org/10.1007/s10212-021-00583-9

Lee, J., Choi, H. J. C., & Education. (2017). What affects learner's higher-order thinking in technology-enhanced learning environments? The effects of learner factors. *115*, 143-152.

Li, K. C., & Wong, B. T.-M. J. A. J. o. E. T. (2021). Review of smart learning: Patterns and trends in research and practice. *37*(2), 189-204.

Lin, H. C., Hwang, G. J., Chang, S. C., & Hsu, Y. D. . (2021). Facilitating critical thinking in decision making-based professional training: An online interactive peer-review approach in a flipped learning context. *Computers and Education*, *173*. https://doi.org/ https://doi.org/10.1016/j.compedu.2021.104266

Linnenbrink, E. A., & Pintrich, P. R. (2000). Multiple pathways to learning and achievement: The role of goal orientation in fostering adaptive motivation, affect, and cognition. In *Intrinsic and extrinsic motivation* (pp. 195-227). Elsevier.

Liu, J., Wang, C., & Xiao, X. J. S. P. (2021). Internet of things (IoT) technology for the development of intelligent decision support education platform. *2021*, 1-12.

Lu, K., Yang, H. H., Shi, Y., & Wang, X. (2021). Examining the key influencing factors on college students' higher-order thinking skills in the smart classroom environment. *International Journal of Educational Technology in Higher Education*, *18*(1), 1–14. https://doi.org/10.1186/s41239-020-00238-7

Li, Y., Yang, H. H., & MacLeod, J. (2019). Preferences toward the constructivist smart classroom learning environment: examining pre-service teachers' connectedness. *Interactive Learning Environments*, *27*(3), 349–362. https://doi.org/10.1080/10494820.2018.1474232

Lu, K., Yang, H., & Xue, H. (2021). Investigating the four-level inquiry continuum on college students' higher order thinking and peer interaction tendencies. *International Journal of Inn*

Miller, A. L., Fassett, K. T., & Palmer, D. L. (2021). Achievement goal orientation: A predictor of student engagement in higher education. *Motivation and Emotion*, *45*(3), 327–344. https://doi.org/10.1007/s11031-021-09881-7

Magno, C. (2010). The role of metacognitive skills in developing critical thinking. *Metacognition and Learning*, *5*(2), 137–156. https://doi.org/10.1007/s11409-010-9054-4

Mao, W., Cui, Y., Chiu, M. M., & Lei, H. J. J. o. E. C. R. (2022). Effects of game-based learning on students' critical thinking: A meta-analysis. *59*(8), 1682-1708.

Marwan, A., Hasruddin, H., Yusnadi, Y. J. B. I. R., Linguistics, C. i., & Journal, E. (2021). The Effect of Guided Inquiry Learning Model on Process Skills Science and Students' Higher-Level Thinking Skills on Heat and Transfer Themes of Class V SD Negeri 104260 Melati. *4*(2), 901-910.

Mete, D. E. (2020). Fostering critical thinking skills in ELT through video-based reflection. Journal of Language and Linguistic Studies. *16*(1). https://doi.org/https://doi.org/10.17263/JLLS.712662

Murthy, S., Iyer, S., Mavinkurve, M., Spector, M., Lockee, B., Childress, M. J. L., Design,, . . . Policy. (2016). Pedagogical framework for developing thinking skills using smart learning environments. 1-49.

Malik, M. A. R., Choi, J. N., & Butt, A. N. (2019). Distinct effects of intrinsic motivation and extrinsic rewards on radical and incremental creativity: The moderating role of goal orientations. *Journal of Organizational Behavior*, *40*(9–10), 1013–1026. https://doi.org/10.1002/job.2403

MacLeod, J., Yang, H. H., Zhu, S., & Li, Y. (2018). Understanding students' perception toward the smart classroom learning environment: Development and validation of an instrument. *Computers and Education*, *122*(March), 80–91.

Nunaki, J. H., Damopolii, I., Kandowangko, N. Y., & Nusantari, E. (2019). The effectiveness of inquiry-based learning to train the students' metacognitive skills based on gender differences. *International Journal of Instruction*, *12*(2). https://doi.org/10.29333/iji.2019.12232a

Öztürk, B., Kaya, M., & Demir, M. (2022). Does inquiry-based learning model improve learning outcomes? A second-order meta-analysis. *Journal of Pedagogical Research*, *6*(4). https://doi.org/10.33902/JPR.202217481

Oliver, M. (2005). The Problem with Affordance. *E-Learning and Digital Media*, *2*(4), 402–413. https://doi.org/10.2304/elea.2005.2.4.402

Pozzi, G., Pigni, F., & Vitari, C. (2014). Affordance theory in the IS discipline: A review and synthesis of the literature. *20th Americas Conference on Information Systems, AMCIS 2014*.

Point, C. (2020). *Live Cyber Threat Map*. Computers and Education

Pintrich, P. R. J. J. o. e. p. (2000). Multiple goals, multiple pathways: The role of goal orientation in learning and achievement. *92*(3), 544.

Prayogi, S., Verawati, N. N. S. P. J. J. o. E., Cultural, & Studies, P. (2020). The effect of conflict cognitive strategy in inquiry-based learning on preservice teachers' critical thinking ability. (21), 27-41.

Preus, B. J. A. S. E. (2012). Authentic instruction for 21st century learning: Higher order thinking in an inclusive school. 59-79.

Priawasana, E., Degeng, I. N. S., Utaya, S., & Kuswandi, D. J. U. J. o. E. R. (2020). An experimental analysis on the impact of elaboration learning on learning achievement and critical thinking. *8*(7), 3274-3279.

Rosmansyah, Y., Putro, B. L., Putri, A., Utomo, N. B., & Environments, S. J. I. L. (2022). A simple model of smart learning environment. 1-22.

Ramdani, A., Jufri, A. W., Gunawan, Fahrurrozi, M., & Yustiqvar, M. (2021). Analysis of students' critical thinking skills in terms of gender using science teaching materials based on the 5e learning cycle integrated with local wisdom. *Jurnal Pendidikan IPA Indonesia*, *10*(2), 187–199. https://doi.org/10.15294/jpii.v10i2.2995

Ruzaman, N. J. I. J. o. E. T. i. L. (2020). Inquiry-based education: Innovation in participatory inquiry paradigm. *15*(10), 4-15.

Spector, J. M. J. S. l. e. (2014). Conceptualizing the emerging field of smart learning environments. *1*, 1-10.

Sugandini, D., Purwoko, Pambudi, A., Resmi, S., Reniati, Muafi, & Kusumawati, R.A. . (2018). The role of uncertainty, perceived ease of use, and perceived usefulness towards the technology adoption. *International Journal of Civil Engineering and Technology*, *9*(4).

Setiyani, Waluya, S. B., Sukestiyarno, Y. L., & Cahyono, A. N. (2022). Mathematical Reflective Thinking Process of Prospective Elementary Teachers Review from the Disposition in Numerical Literacy Problems. In *International Journal of Educational Methodology* (Vol. 8, Issue 3). https://doi.org/10.12973/IJEM.8.3.405

Tang, Y. (2019). From CLA to CLA+: An Analysis of the Value-added Evaluation Model of Higher Order Thinking Ability in American Higher Education. *ModernEducationManagement,(02*(119124). https://doi.org/DOI:10.16697/j.cnki.xdjygl.2019.02.022

Vandewalle, D., Nerstad, C. G., Dysvik, A. J. A. R. o. O. P., & Behavior, O. (2019). Goal orientation: A review of the miles traveled and the miles to go. *6*, 115-144.

Verawati, N. N. S. P., Hikmawati, Prayogi, S., & Bilad, M. R. (2021). REFLECTIVE PRACTICES IN INQUIRY LEARNING: ITS EFFECTIVENESS IN TRAINING PRE-SERVICE TEACHERS' CRITICAL THINKING VIEWED FROM COGNITIVE STYLES. *Jurnal Pendidikan IPA Indonesia*, *10*(4). https://doi.org/10.15294/jpii.v10i4.31814

Verawati, N. N. S. P., Prayogi, S., Gummah, S., Muliadi, A., & Yusup, M. Y. (2019). The effect of conflict-cognitive strategy in inquiry learning towards pre-service teachers' critical thinking ability. *Jurnal Pendidikan IPA Indonesia*, *8*(4). https://doi.org/10.15294/jpii.v8i4.21002

Wang, H. J. I. J. o. C., & Sciences, L. (2014). Learner autonomy based on constructivism learning theory. *8*(5), 1552-1554.

Wang, C., Fang, T., & Gu, Y. (2020). Learning performance and behavioral patterns of online collaborative learning: Impact of cognitive load and affordances of different multimedia. *Computers and Education*, *143*(5), 103683. https://doi.org/10.1016/j.compedu.2019.103683

Williams, M. K. (2017). John Dewey in the 21st century. *Journal of Inquiry and Action in Education*, *9*(1).

Wijnands, A., van Rijt, J., Stoel, G., Coppen, P.-A. J. L., & Education. (2022). Balancing between uncertainty and control: Teaching reflective thinking about language in the classroom. *71*, 101087.

Yu, L., Wu, D., Yang, H. H., & Zhu, S. J. A. J. o. E. T. (2022). Smart classroom preferences and information literacy among college students. *38*(2), 142-161.

Zhang, L., Du, X., Hung, J.-L., Li, H. J. I. D., & Delivery. (2021). Learning preference: development in smart learning environments. *49*(2), 174-187.

Zhang, S. (2018). The Level and increment of Critical Thinking Ability of Undergraduate students in Top Universities: Based on the Empirical analysis ofthe Ability evaluation of Undergraduate students *China ElectroChemical Education,*

EducationalResearch.109117.https://kns.cnki.net/kcms2/article/abstract?v=3uoqIhG8C44YLTlOAiTRKibYlV5Vjs7iLik5jEcCl09uHa3oBxtWoNDojd8EOOvWf2K9vtwqPEjZr9w9XgdgGS6sJE6P15q&uniplatform=NZKPT& src=copy

Zhong, X. (2017). A study on the influencing factors and cultivation strategies of critical thinking development among college students. *Educational Research*, *(05),6776*. https://kns.cnki.net/kcms2/article/abstract?v=3uoqIhG8C44YLTlOAiTRKibYlV5Vjs7iAEhECQAQ9aTiC5BjCgn0RgAmAvK_pgFrX1ROAF4ufq89_5N9Xr1R46gaVM1Dd5La&uniplatform=NZKPT&src=copy

Zhu, Q. (2020). Design and implementation of smart classroom system based on internet of things technology. Recent Trends in Intelligent Computing, Communication and Devices: Proceedings of ICCD 2018,

Zaccone, M. C., & Pedrini, M. (2019). The effects of intrinsic and extrinsic motivation on students learning efectiveness. Exploring the moderating role of gender. *International JournalofEducationalManagement*,33(6),1381–1394. http://dx.doi.org/10.1108/IJEM-03-2019-0099

Zhao,(2021).The relationship between learning strategies and learning effectiveness in college English:The moderating effect of learning motivation. *Modern Distance Education* (02), 26-34. doi:10.13927/j.cnki.yuan.20210208.011.